FOREST RESEARCH REPORT

NOVA SCOTIA DEPARTMENT OF LANDS AND FORESTS
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CONTROL OF HARDWOOD COMPETITION BY INJECTION OF GLYPHOSATE OR GIRDLING

INTRODUCTION

Residual trees left on cutovers following harvesting (usually hardwoods) can present obstacles to forest improvement. These trees suppress and damage younger trees, create hazards for low-flying aircraft applying pesticides, act as a seed source, and interfere with future harvesting (Wile, 1981). In addition, the inherent capacity of hardwoods for vegetative reproduction following cutting can create problems when coppice regeneration is deemed undesirable (MacGillivray, 1960).

Forest managers have several options suitable for dealing with these types of conditions:

1) removing the trees from the site by harvesting;
2) girdling or injecting the trees with herbicide to induce mortality and leaving the trees standing on site, or
3) girdling or injecting the trees followed by harvesting.

In this study, established in 1984 at Alpena, Annapolis County, residual trees were either girdled or injected with the herbicide Vision® (active ingredient glyphosate) using the hack and squirt method[1] of application, then harvested 1 or 2 years later. The objectives of the study were:

1) to determine the ability of Vision® to control vegetative reproduction of hardwoods, both before and after harvesting, when injected into the parent tree prior to cutting;
2) to develop alternative methods of killing unwanted residual hardwood trees.

SITE DESCRIPTION

The treatment site consisted of 13.6 acres of mature hardwood, comprised of 50% red maple *(Acer rubrum* L.) (rM), 17% white birch *(Betula papyrifera* Marsh.) (wB), 16% aspen (A.), predominantly largetooth aspen *(Populus grandidentata* Michx.), and 14% red oak *(Quercus rubra* L.) (rO).

The area was divided into 22 blocks of varying length, each 66 feet wide. Block size ranged from 0.10 acres to 1.6 acres; average size was 0.62 acres.

® Registered Trademark of Monsanto Company Ltd. Trade name was changed from Roundup® to Vision® as of 1987.

1 method of killing undesired trees by making one or several overlapping axe cuts into the sapwood to which herbicide is applied

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Nova Scotia Department of Lands and Forests

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METHODS

Half the width of each block was treated in the fall of 1984. The other half was left as a buffer zone. Half the length of each treated strip was cut in the fall of 1985 with the remaining half harvested in the fall of 1986. Five different rates of Vision® were applied in September of 1984 using the hack and squirt method of application. Treatment rates varied from 20% Vision® (1 part Vision® to 4 parts water) to 100%. Hacks were made at breast height (1.3 m) at a 45° angle using a curved axe which created a cup-shaped wound designed to reduce herbicide run-off. The herbicide solution was then injected with a Repipet Jr[1] dispenser at the rate of 1 ml into each hack. Each mature hardwood tree within the study area received a treatment except for those within control blocks and buffer zones. Distance between hacks varied with treatment and method (Table 1). For treatments where no herbicide was applied, a chain-saw was used to girdle the tree. The area between cuts was scraped back to remove the cambium layer.

Table 1. A listing of treatments by method of application and herbicide concentration (%).

Method of Application	Method Description			Herbicide Concentration (%)
1) 2 in. apart	Hacks 2 in. apart around tree at breast height			20,25,33,50
2) 1-4 hacks*	Dbh Class	≤4 in.	1 Hack	50,100
		5-8	2 Hacks	
		9-12	3 Hacks	
		13-16+	4 Hacks	
3) 1-2 hacks*	Dbh Class	≤8 in.	1 Hack	100
		≥9 in.	2 Hacks	
4) Single band girdle	Girdle with chain-saw; Single band - width of chain			0
5) Double band girdle	Girdle with chain-saw; Double band - 3 in. apart (bark removed between bands)			0

* The number of hacks made around tree at breast height depends on the diameter at breast height of that tree

Sample trees were chosen in the fall of 1984 on the basis of species and diameter. In each strip, where possible, 5 trees from each diameter class and species group were randomly selected. Assessments were conducted in the fall of 1985 and each year thereafter until 1988. Sample trees were assessed for tree vigour, percent topkill and abnormal tree growth. So that sprouting could be monitored following harvesting, metal tags were attached to the base of each sample tree and the area around the tag sprayed with fluorescent orange paint. Sprouting was assessed before and after cutting. Information recorded included the number of sprouts per stump, average sprout height, overall sprouting vigour and abnormal growth.

RESULTS

CROWN MORTALITY OF MATURE HARDWOOD TREES

Herbicide Concentration

Figure 1 illustrates the effect of herbicide concentration on crown mortality (%topkill) of treated hardwoods based on assessments conducted in August of 1985, the first year following treatment. For most species, the level of topkill declined as the concentration of herbicide was reduced. Although treatment responses vary considerably by species, concentrations of 100 and 50% herbicide respectively, were generally the most effective.

1 Registered Trademark of Labindustries

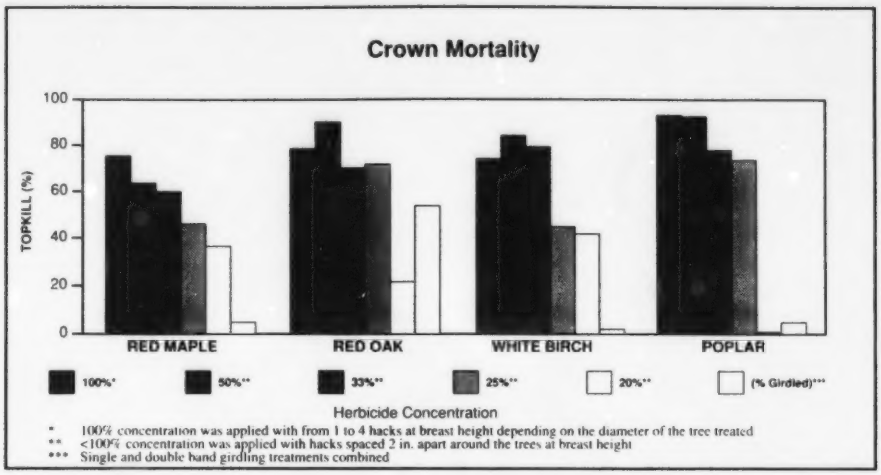


Figure 1. Average percent topkill by species and treatment (1 year results).

Two years after treatment, the 50 and 100% concentrations maintained high levels of topkill, although the difference between all concentrations was considerably less (Table 2). This would indicate that lower concentrations (25 and 33% herbicide) are slower to act but in the longer term are equally effective.

Hack Method

Table 3 indicates that average "first year" topkill, for the 50 and 100% concentration levels, was influenced by the number of hacks. The greater the number, the higher the mortality. For example, an 8 inch diameter tree, would have been hacked once (1 ml of herbicide solution) when using the 1-2 hack method, as opposed to twice with the 1-4 hack method (2 mls of herbicide solution). By doubling the number of hacks, at the 100% herbicide level, the average topkill was doubled over all species (80 vs 41%) (Table 3, Figure 2).

In this study, the most effective method, on average, proved to be 1 hack applied for every 2 inches of diameter. In combination with the 50% concentration level, this method produced the greatest topkill. Had the 2 in. hack method been applied, in conjunction with 100% herbicide concentration, it is likely that this treatment would have resulted in the highest levels of crown mortality.

Table 2. Average percent topkill and percentage of trees with greater than 90% (>90) topkill by species, treatment and method of application recorded 2 years after initial treatment.

Treatment	Method	Topkill									
		rM		rO		wB		A.		Average	
(% Herbicide)	(# Hacks)	%	>90	%	>90	%	>90	%	>90	%	>90
100	* 1-2 Hacks	79	71	65	25	40	25	59	35	61	39
100	** 1-4 Hacks	80	73	95	93	50	-	89	88	79	85
50	1-4 Hacks	78	50	100	100	100	100	48	29	81	70
50	***2 in. Apart	74	57	85	81	91	86	80	75	83	75
33	2 in. Apart	80	69	93	92	79	73	76	66	82	75
25	2 in. Apart	84	59	69	61	72	45	70	57	74	54
20	2 in. Apart	-	-	-	-	-	-	-	-	-	-
0	****Girdle	70	60	80	41	55	80	68	54	68	59
Average (excluding girdling):										77	66

* 1-2 Hacks: ≤8 in. dbh = 1 Hack; ≥9 in. dbh = 2 Hacks.
** 1-4 Hacks: ≤4 in. dbh = 1 Hack; 5-8 in. dbh = 2 Hacks; 9-12 in. dbh = 3 Hacks; 13-16+ in. dbh = 4 Hacks.
*** Hacks made 2 in. apart around tree at breast height.
**** Single and double band girdling treatments combined.

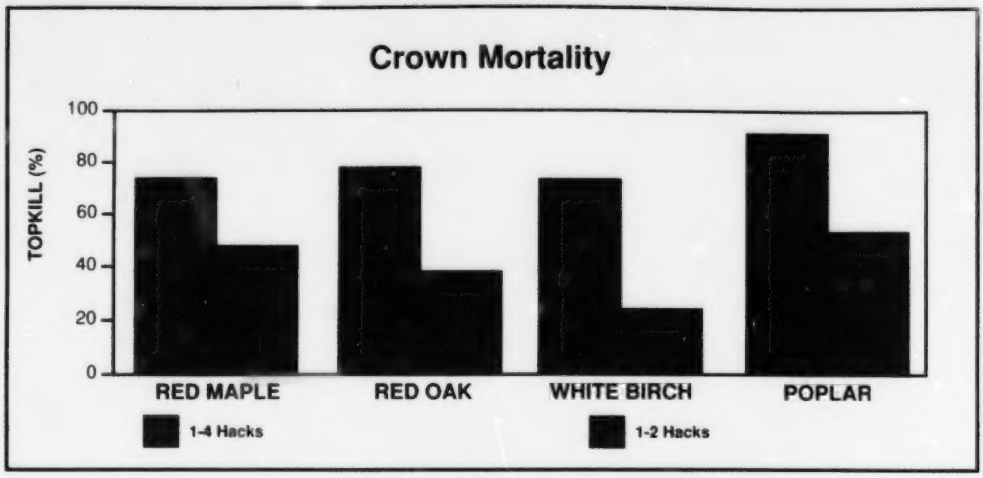


Figure 2. Average percent topkill of blocks treated with a 100% concentration of Vision® by species and number of hacks per tree (1 year after treatment).

Tree Diameter

As part of the data analysis, the relationship between topkill and tree diameter was also examined. Although this relationship was weak, it did show topkill decreasing slightly as diameters increased in size (data not presented).

Girdling

Girdling proved the least effective method of inducing crown mortality in the first year, producing on average, a topkill of 16% in comparison to 60% for herbicide treatments (Table 3). If red oak is excluded from this total, the average effect of the 2 girdling treatments on red maple, white birch, and aspen was just 3% topkill. Two years after treatment though, the average had increased to 68%, with 59% of the trees recording greater than 90% crown mortality (Table 2). By comparison, the level of topkill recorded in response to herbicide treatments was 77%, with 66% of the trees having greater than 90% topkill.

Table 3. Average percent topkill and percentage of trees with greater than 90% (>90) topkill by species, treatment and method of application recorded 1 year after initial treatment.

Treatment	Method	Topkill									
		rM		rO		wB		A.		Average	
(% Herbicide)	(# Hacks)	%	>90	%	>90	%	>90	%	>90	%	>90
100	* 1-2 Hacks	48	38	38	-	24	33	53	40	41	37
100	** 1-4 Hacks	75	55	78	71	74	63	93	90	80	70
50	1-4 Hacks	43	25	54	43	56	38	68	38	55	36
50	***2 in. Apart	64	47	90	78	84	80	92	83	83	72
33	2 in. Apart	60	45	70	51	79	68	78	69	72	58
25	2 in. Apart	46	31	71	54	45	25	74	62	59	43
20	2 in. Apart	36	13	21	0	42	23	-	-	33	12
0	****Girdle	4	10	54	48	1	11	4	3	16	18
Average (excluding girdling):										60	47

* 1-2 Hacks: ≤8 in. dbh = 1 Hack; ≥9 in. dbh = 2 Hacks.
** 1-4 Hacks: ≤4 in. dbh = 1 Hack; 5-8 in. dbh = 2 Hacks; 9-12 in. dbh = 3 Hacks; 13-16+ in. 4 Hacks.
*** Hacks made 2 in. apart around tree at breast height.
**** Single and double band girdling treatments combined.

COPPICE GROWTH

Discussion of coppice growth will be limited to the number of sprouts/stump. As a result of heavy browsing over the study area, sprout height was omitted from the analyses of data.

The level of sprouting was recorded at 4 time intervals; 1 year following treatment (just prior to harvesting the mature hardwoods), and 1, 2 and 3 years after the 1985 harvest. The same information on sprouting from blocks harvested in 1986 was collected and summarized, but due to the similarity in trends with the 1985 data, is not included. No data on aspen suckering was collected.

Pre-Harvest

The pre-cut information presented in Table 4 and Figure 3 represents the level of sprouting which occurred 1 year following treatment. The data shows that for rM, all treatments induced sprouting, but girdling considerably more so than herbicide treatments (3 vs. 18 sprouts/stump). With rO and wB, sprouting 1 year after herbicide treatments (pre-cut) was either absent or minimal, usually limited to fewer than 1 sprout/stump. For the most part, the treatments which resulted in the greatest first year topkill of the mature trees caused the least amount of sprouting.

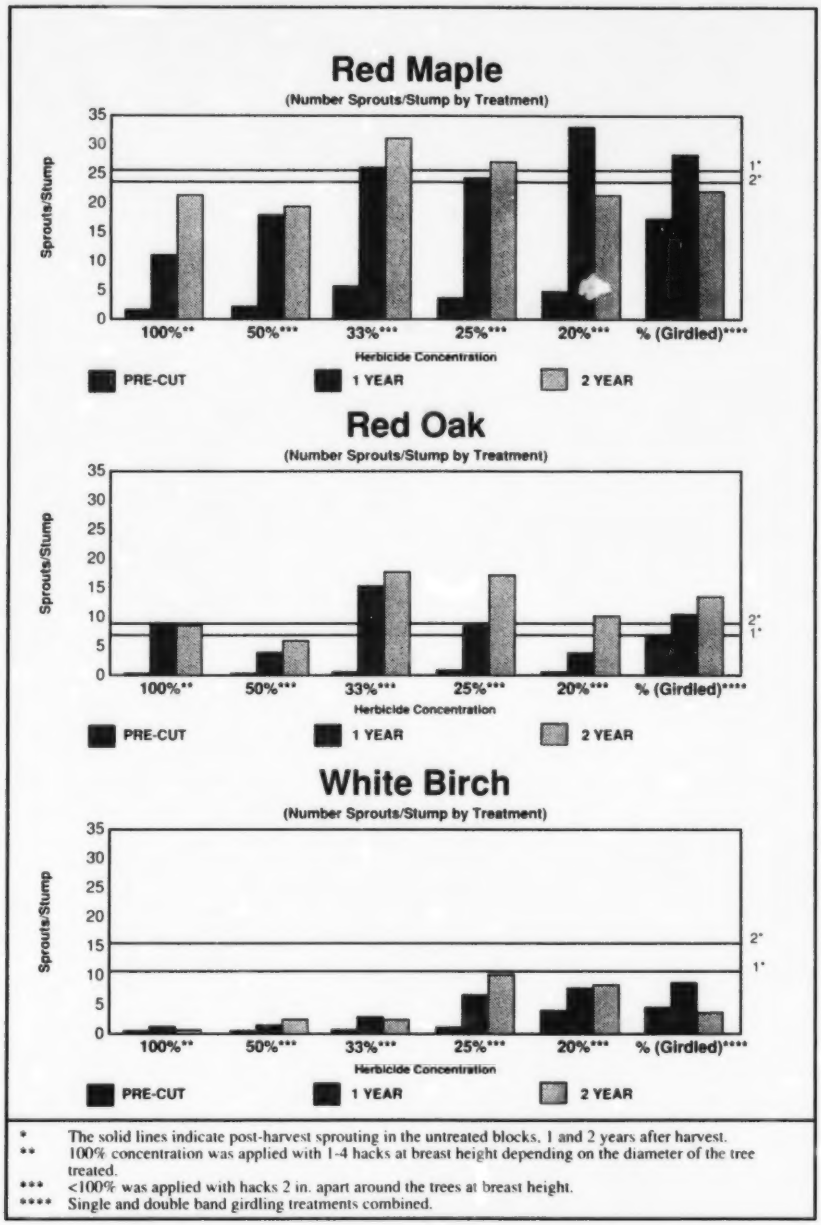
Post-Harvest

The data presented in Table 4 and Figure 3 show that none of the treatments were completely effective in controlling sprouting of rM, in any of the years following harvest. On the other hand, sprouting of rO was completely controlled only by the 100% herbicide applied with the 1-2 hack method. For wB, the 100% treatment produced similar control but only with 1-4 hacks. For both species this control was maintained 2 years following harvest. As with first year topkill, the 50 and 100% treatments provided the best control but unlike topkill, the results were not greatly influenced by the number of hacks.

Table 4. The number of sprouts per stump which occurred 1 year after treatment (pre-harvest) and 1 and 2 years after harvesting in 1985.

Number of Sprouts/Stump													
Treat.	Method	rM			rO			wB			Average		
(% Herbicide)	(# Hacks)	Pre[1]	1[2]	2[3]	Pre	1	2	Pre	1	2	Pre	1	2
100	1-2 Hacks*	3.0	23.6	13.3	0.0	0.0	0.0	0.2	5.8	11.9	1.1	9.8	8.4
100	1-4 Hacks**	1.3	11.0	21.9	0.0	8.6	8.0	0.2	1.1	0.5	0.5	6.9	10.1
50	1-4 Hacks	3.1	13.3	24.1	1.2	4.3	10.8	1.4	2.1	7.9	1.9	6.6	14.3
50	2 in. Apart***	1.8	18.3	19.9	0.0	3.2	5.2	0.0	1.0	2.2	0.6	7.4	9.1
33	2 in. Apart	5.4	26.8	31.6	0.1	14.6	17.3	0.8	2.4	2.1	2.1	14.6	17.0
25	2 in. Apart	2.9	24.8	27.7	1.0	7.9	16.9	0.7	6.4	9.8	1.5	13.0	18.1
20	2 in. Apart	3.9	33.2	21.3	0.0	3.2	9.8	3.5	7.4	7.9	2.5	14.6	13.0
0	Girdle****	17.5	28.4	22.2	6.5	10.3	13.3	3.1	8.3	3.0	9.0	15.7	12.8
0	Control	0.2	27.1	25.3	0.0	7.1	9.3	0.0	11.4	15.7	0.1	15.2	16.8

Pre[1]: Pre-cut (sprouting which occurred following initial application of herbicide and before harvesting of mature trees).
1[2]: 1 year after harvest (1986).
2[3]: 2 years after harvest (1987).
* 1-2 Hacks: ≤ 8 in. dbh = 1 Hack ≥9 in. dbh = 2 Hacks.
** 1-4 Hacks: ≤ 4 in. dbh = 1 Hack; 5-8 in. dbh = 2 Hacks; 9-12 dbh = 3 Hacks; 13-16+ in. dbh = 4 Hacks.
*** Hacks made 2 in. apart around tree at breast height.
**** Single and double band girdling treatments combined.



* The solid lines indicate post-harvest sprouting in the untreated blocks, 1 and 2 years after harvest.
** 100% concentration was applied with 1-4 hacks at breast height depending on the diameter of the tree treated.
*** <100% was applied with hacks 2 in. apart around the trees at breast height.
**** Single and double band girdling treatments combined.

Figure 3. The number of sprouts/stump by concentration of Vision® that occurred following treatment and prior to harvesting (pre-cut), and 1 and 2 years after the harvesting.

SUMMARY

The major results of a study to determine the ability of girdling and injection of Vision®to kill hardwoods and control vegetative reproduction are as follows:

1) The greater the concentration of herbicide applied, the greater the topkill (crown mortality). Herbicide concentrations of 100% (applied with 1-4 hacks) and 50% (hacks 2 in, apart) were most effective for inducing topkill. For these treatments, 2 years after herbicide application, average crown mortality over all species was 81%, and 80% of the trees treated had greater than 90% crown kill.

2) For the higher concentration levels (50 and 100% Vision®), the greater the number of hacks, the greater the topkill.
3) Girdling proved the least effective method for inducing crown mortality in the first year, producing in red maple, white birch and aspen, a combined effect of 3%. However, two years after treatment, topkill levels had increased to 68%.
4) Lower concentrations of herbicide (<50%) produced less topkill the first year after treatment, but by year 2, topkill was about the same as for the higher concentrations. This would indicate that lower concentrations are slower to react, but can be expected to perform as well in the long run.
5) No treatments were completely effective in controlling red maple sprouting. In fact, both girdling and herbicide treatments induced sprouting prior to harvesting. However, girdling stimulated sprouting more so than herbicide treatments (3 vs 18 sprouts/stump). After harvest the number of sprouts increased dramatically.
6) Sprouting in white birch was effectively controlled for the 3 year measurement period at the 100% herbicide concentration, applied with hacks 2 inches apart.
7) For red oak, pre and post-cut sprouting was controlled for the 3 year measurement period at the 100% herbicide treatment administered with 1-2 hacks (≤ 8 in. dbh = 1 hack; ≥ 9 in.dbh = 2 hacks).

LITERATURE CITED

MacGillivray, H.G. 1960. A pre-felling treatment to prevent sprouting of red maple. Forest Research Branch, Dept. of Forestry, Fredericton, N.B. Technical Note, 1pp.

Wile, B.C. 1981. A test of five herbicides and three ground application methods for cleaning young stands in clearcut areas. Mar. For. Res. Cen., Fredericton, N.B. Infor. Rept. M-X-126.

MANAGEMENT RECOMMENDATION

To induce crown mortality in mature-residual A, rM, wB and rO trees, inject 1 ml. of solution, having at least 50% concentration of Vision®, into hacks made at breast height, and spaced 2 inches apart. For best control of sprouts, especially rM, do not harvest the standing trees after treatment.

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